

WE CLAIM:

1. A method of detecting a face in a colour digital image, said method comprising the steps of:

- 5 (i) segmenting said image into a plurality of regions each having a substantially homogenous colour;
- (ii) testing the colour of each said region created in step (i) to determine those regions having predominantly skin colour; and
- (iii) subjecting only the regions determined in step (ii) to further facial
- 10 feature analysis whereby said regions created in step (i) not having a predominantly skin colour are not subjected to said further feature analysis.

2. The method as claimed in claim 1 including the further step of using in step (ii) a colour distribution model utilising previously sampled data.

15 3. The method as claimed in claim 1 including the further step of using chromatic colours derived from RGB values in step (ii).

4. The method as claimed in claim 1 wherein said image is from a camera.

20 5. The method as claimed in claim 4 wherein a particular image is selected from the group consisting of images taken with use of a flash, and images taken without use of a flash.

6. The method as claimed in claim 1 wherein the further facial analysis in step (iii) is independent of facial colour.

7. The method as claimed in claim 5 wherein the further facial analysis comprises
5 edge detection.

8. The method as claimed in claim 6 wherein said edge detection utilises an edge
detection filter comprising second derivative Gaussian function in a first direction
substantially orthogonal to the edge to be detected and a Gaussian function in a second
10 direction substantially orthogonal to said first direction.

9. The method as defined in claim 6 or 7 wherein further facial analysis is carried
out utilising the spatial relationship of detected edges.

10. The method as defined in claim 1 wherein step (i) includes growing a region by
determining the average colour of a group of pixels, determining the difference between
the average colour of the group and the average colour of pixels adjacent to the group,
and, if the colour difference is less than a predetermined threshold, adding the adjacent
pixels to the group.
15

11. Apparatus for detecting a face in a colour digital image, said apparatus
comprising,
20 segmenting means to segment said image into a plurality of regions each having
a substantially homogeneous colour,

colour detecting means coupled to said segmenting means to determine those regions having predominantly skin colour,

analysis means coupled to said colour detection means to subject only those regions having predominantly skin colour to a facial feature analysis.

5

12. The apparatus as claimed in claim 11 wherein said colour detection means includes a colour distribution model and storage means storing previously sampled data for use in said colour distribution model.

10 13. The apparatus as claimed in claim 12 including chromatic colour calculations means to derive from RGB values of said image, chromatic colour values.

14. The apparatus as claimed in claim 11 wherein said image is from a camera.

15 15. The apparatus as claimed in claim 11 wherein the particular image is selected from the group consisting of images taken with use of a flash, and images taken without use of a flash.

20 16. The apparatus as claimed in claim 11 wherein said facial feature analysis of said analysis means is independent of facial colour.

17. The apparatus is claimed in claim 10 wherein said analysis means includes an edge detector to detect edges in the image.

18. The apparatus as claimed in claim 17 wherein said analysis means has an edge detection filter comprising second derivative Gaussian function in a first direction substantially orthogonal to the edge to be detected and a Gaussian function in a second direction substantially orthogonal to said first direction.

5

19. The apparatus as claimed in claim 17 wherein said analysis means includes a spatial determinator to determine the spatial relationship of detected edges.

10

20. The apparatus as claimed in claim 11 including an accumulator means and a colour difference means to determine the difference between the average colour of a group of pixels and the average colour of pixels adjacent to that group, since that if the colour distance is less than a predetermined threshold, said adjacent pixels are added to said accumulator means to thereby grow a region.

15

21. A computer readable medium incorporating a computer program product for detecting a face in a colour digital image, said computer program product including a sequence of computer implementable instructions for carrying out the steps of:

(i) segmenting said image into a plurality of regions each having a substantially homogenous colour;

20

(ii) testing the colour of each said region created in step (i) to determine those regions having predominantly skin colour; and

(iii) subjecting only the regions determined in step (ii) to further facial feature analysis whereby said regions created in step (i) not having a predominantly skin colour are not subjected to said further feature analysis.

25

22. The medium as claimed in claim 21 including the further step of using in step (ii) a colour distribution model utilising previously sampled data.

23. The medium as claimed in claim 21 including the further step of using chromatic
5 colours derived from RGB values in step (ii).

24. The medium as claimed in claim 21 wherein said image is from a camera.

25. The medium as claimed in claim 21 wherein the particular image is selected
10 from the group consisting of images taken with use of a flash, and images taken without use of a flash.

26. The method as claimed in claim 21 wherein the further facial analysis in step (iii)
15 is independent of facial colour.

27. The medium as claimed in claim 26 wherein the further facial analysis comprises edge detection.

28. The medium as claimed in claim 27 wherein said edge detection utilises an edge
20 detection filter comprising second derivative Gaussian function in a first direction substantially orthogonal to the edge to be detected and a Gaussian function in a second direction substantially orthogonal to said first direction.

29. The medium as defined in claim 26 wherein further facial analysis is carried out
25 utilising the spatial relationship of detected edges.

30. The medium as defined in claim 21 wherein step (i) includes growing a region by determining the average colour of a group of pixels, determining the difference between the average colour of the group and the average colour of pixels adjacent to the group, and, if the colour difference is less than a predetermined threshold, adding the adjacent pixels to the group.

31. A method of detecting a face in a colour digital image formed of a plurality of pixels, said method comprising the steps of:

10 (i) testing the colour of said pixels to determine those said pixels having predominantly skin colour, said testing utilising at least one image capture condition provided with said image; and

(ii) subjecting only said those pixels determined in step (i) as having predominantly skin colour to further facial feature analysis whereby those said pixels not
15 having a predominantly skin colour are not subjected to said further facial feature analysis.

32. A method according to claim 31 wherein each said image capture condition is acquired at a time said image is captured.

20 33. A method according to claim 32 wherein said image is encoded according to a predetermined format and said at least one image capture condition is represented as meta-data associated with said format.

34. A method according to claim 31 wherein said at least one image capture condition comprises lighting conditions at a time said image was captured.

35. A method according to claim 31 wherein step (i), comprises the sub-step,
5 preceding said testing, of:

(a) dividing said image into a plurality of regions, each said region comprising a plurality of said pixels; and

wherein said testing is performed on pixels within each said region to determine those ones of said regions that are predominantly skin colour and step (ii) comprises
10 performing said further facial feature analysis on only those said regions determined to be predominantly of skin colour.

36. A method according to claim 31 wherein step (i) utilises at least one predetermined colour distribution model, said model having been generated using
15 previously sampled facial image data.

37. A method according to claim 36 wherein said colour distribution model is generated for a particular image capture device.

20 38. A method according to claim 36 wherein separate colour distribution models are generated for said different image capture conditions.

39. A method according to claim 38 wherein said at least one image capture condition comprises lighting conditions at a time said image was captured and separate

colour models are generated for different lighting conditions at a time said previously sampled facial image data was captured.

40. A method according to claim 39 wherein separate colour distribution models are
5 generated for groups of images taken with a flash and images taken without a flash.

41. A method according to claim 39 wherein separate colour distribution models are generated for groups of images taken indoors and images taken outdoors.

10 42. A method according to claim 36 wherein each said colour distribution model is represented as a frequency histogram of colour representation vectors.

43. A method according to claim 36 wherein each said colour distribution model is represented as a probability distribution of colour representation vectors.

15 44. A method according to claim 36 wherein each said colour distribution model is represented as a binary map of colour representation vectors.

45. A method according to claim 42, 43 or 44 wherein said colour representation
20 vectors are derived from perceptual colour space values of the predetermined skin-colour pixels in said previously sampled facial image data.

46. A method according to claim 42, 43 or 44 wherein said colour representation
25 vectors contain chromatic colour values derived from those RGB values of the predetermined skin-colour pixels in said previously sampled facial image data.

47. A method according to claim 44 wherein said binary map comprises a percentage of the skin colour pixels that were identified in said previously sampled facial image data.

5

48. A method according to claim 47 wherein one of said pixels is classified as being skin colour if the colour representation vector corresponding thereto occurs within said binary map.

10

49. A method according to claim 42 wherein each of said pixels is classified as being skin colour if the frequency of the colour representation vector corresponding thereto exceeds a predetermined threshold frequency.

15

50. A method according to claim 44 wherein each of said pixels is classified as being skin colour if the probability of the colour representation vector corresponding thereto exceeds a predetermined probability threshold.

20

51. A method according to claim 48 wherein one said regions is determined to be predominantly skin colour if more than a predetermined percentage of the total number of said pixels in said one region are classified as being skin colour.

52. A method according to claim 35 wherein said regions are geometrically divided from said image.

3

53. A method according to claim 35 wherein said regions are formed of pixels having substantially homogenous colour.

54. A method according to claim 53 wherein said regions are formed using a region growing method based upon colour differences.

55. A method according to claim 35 wherein said further analysis of step (ii) is independent of face colour.

10 56. Apparatus for detecting a face in a colour digital image formed of a plurality of pixels, said apparatus comprising:

means for testing the colour of said pixels to determine those said pixels having predominantly skin colour, said testing utilising at least one image capture condition provided with said image; and

15 means for subjecting only said those pixels so determined as having predominantly skin colour to further facial feature analysis whereby those said pixels not having a predominantly skin colour are not subjected to said further facial feature analysis.

20 57. Apparatus according to claim 56 wherein each said image capture condition is acquired at a time said image is captured.

58. Apparatus according to claim 57 wherein said image is encoded according to a predetermined format and said at least one image capture condition is represented as
25 meta-data associated with said format.

59. Apparatus according to claim 56 wherein said at least one image capture condition comprises lighting conditions at a time said image was captured.

5 60. Apparatus according to claim 56 wherein said means for testing comprises means for dividing said image into a plurality of regions, each said region comprising a plurality of said pixels;

wherein said means for testing operates on pixels within each said region to determine those ones of said regions that are predominantly skin colour and said means
10 for subjecting cause said further facial feature analysis to be performed on only those said regions determined to be predominantly of skin colour.

61. A computer readable medium incorporating a computer program product for detecting a face in a colour digital image formed of a plurality of pixels, said computer
15 program product comprising:

means for testing the colour of said pixels to determine those said pixels having predominantly skin colour, said testing utilising at least one image capture condition provided with said image; and

means for subjecting only said those pixels so determined as having
20 predominantly skin colour to further facial feature analysis whereby those said pixels not having a predominantly skin colour are not subjected to said further facial feature analysis.

62. A computer readable medium according to claim 61 wherein each said image
25 capture condition is acquired at a time said image is captured.

63. A computer readable medium according to claim 62 wherein said image is encoded according to a predetermined format and said at least one image capture condition is represented as meta-data associated with said format.

5

64. A computer readable medium according to claim 61 wherein said at least one image capture condition comprises lighting conditions at a time said image was captured.

65. A computer readable medium according to claim 61 wherein said means for testing comprises means for dividing said image into a plurality of regions, each said region comprising a plurality of said pixels;

10

wherein said means for testing operates on pixels within each said region to determine those ones of said regions that are predominantly skin colour and said means for subjecting cause said further facial feature analysis to be performed on only those said regions determined to be predominantly of skin colour.

15